STATE & PRIVATE FORESTRY
FOREST HEALTH PROTECTION
SOUTH SIERRA SHARED SERVICE AREA

Report SSSA 12-03

Date: October 31, 2011
File No. 3420

TO: Susan Skalski, Forest Supervisor, Stanislaus National Forest
Margaret Dowd, Groveland District Ranger

SUBJECT: Biological Assessment of Insect and Diseases on Reynolds Creek Project
Groveland Ranger District, Stanislaus National Forest

On September 9, 2011 Forest Health Protection Beverly M. Bulaon and Martin MacKenzie met with Ken Romberger (District Resource Manager) and Johanna Nosal (Forester/District Silviculturist), to review several sites of the Reynolds Creek Ecological Restoration project. FHP followed up with additional visits on other sites of the project to get a better understanding of current forest stand conditions, effects of past management history, and current insect and disease activities. This report is a summarization of observations, general pest biology, and potential management recommendations to consider for Reynolds project.

Introduction

Reynolds Creek was identified as an area in need of management by the Stewardship and Fireshed Assessment (SFA). The project is located within the Clavey River Watershed, high priority also identified by Forest watershed assessments (see Figure 1). Project objectives focus on conversion of species composition to a more historical distribution (promoting shade-intolerant pine and oak), fire reintroduction, aspen habitat improvement, meadow improvement/expansion, and road work and maintenance. Specific forest health objectives will include root disease management, reduction of dwarf mistletoe infection and distribution, mitigate bark beetle associated mortality, and improve overall tree vigor to increase resistance against attack or infection.

Reynolds Creek is located northwest of Cherry Lake (Township 2 N, Range 18 E, Sections 1- 3, 9-16, 21-23; Township 2 N, Range 19 E, Sections 5-8, 18; Township 3 N, Range 18 E, Section 35; Township 3 N, Range 19 E, Section 31).

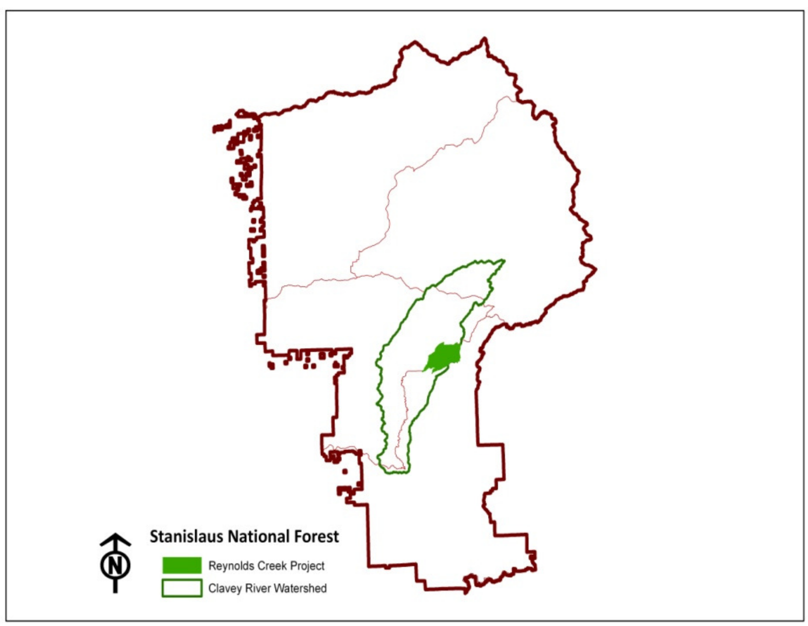


Figure 1. *Reynolds Creek project area spatial reference within the Clavey River Watershed, Stanislaus National Forest.*

It ranges in elevation from 5,000 to 7,000 feet, primarily all of the project is within mixed conifer forest type. Annual precipitation ranges from 28 to 74 inches (average 48 inches); site indexes average Dunning Site 75.

Jeffrey pine, sugar pine, white fir, incense cedar, and red fir are the main conifer species with black oak comprising less than 10% of the landscape. Manzanita, white thorn *Ceanothus*, and chinquapin are thick in gap openings, but taper off quickly when overhead canopy becomes dense. Due to historical logging or site conditions, vegetation has shifted to predominantly white fir, especially on colder north aspects where white fir can comprise over 70% of the composition, over- and understory (see Figure 2 below).

Figure 2. Current stand conditions of mixed conifer fir, Reynolds Creek Project.

Historical photos show intense railroad logging throughout most of the project area in the 1930s-1950s. Salvage logging had been conducted a few times in the mid 80's and 90's within Reynolds Creek; recent treatments have been outside of the project boundaries. Large diameter pines and firs are second growth resulting from those periods; a few legacy sized individuals of ponderosa, sugar pines, and red firs stick out among the rest. Several ponderosa pine plantations (2-3 acres in size, 8 acres the largest) are scattered within the project area, as well as a white fir Progeny genetics plantation. Pine plantations attempted on north facing slopes do not appear to have succeeded as those on south faces. Most current stand conditions in the pine and fir types appear densely stocked with SDI ranges of 352 to 701, basal areas 218 to 427 ft2/acre. Stand exams show average to be about 541 SDI, basal area326 ft2/acre. Vigorous growing ponderosa pine plantations show stocking is about 400 trees per acre.

Fir Engraver (*Scolytus ventralis*), a primary bark beetle of true firs, caused widespread mortality in the early 1990's, and recently in 2008 to 2010 (ADS, Forest Health Monitoring). Trees were most likely attacked in response to severe drought periods (Felix et al 1971) that occur often in California compared to other states. Salvage logging of beetle-killed trees was conducted along roadsides in 1991.

<u>Observations</u>

Aerial detection surveys from 2008 to 2010 (Forest Health Monitoring 2008, 2009, 2010) show multiple polygons within project boundaries of fir engraver-associated mortality (see Appendix A). Dead trees per acre

averaged 1 to 6, but affected acreage ranged from 3 up to 100 acres (median 40 acres). Detected acres also appeared in similar locations, polygons overlapped from year to year. Small pockets of less than 1 to 5 acres were detected of Jeffrey, sugar, or Ponderosa pine mortality (<5 trees per acre).

Ground surveys of fir engraver damage were often observed as top-kill or whole-tree attack. Fir engraver-associated mortality was scattered throughout the project area, often near root disease identified areas or along forest edges. Top-kill by fir engraver often occurs during years of drought, forked tops result from loss of leaders; both of which were evident throughout the project on mature trees. Group mortality by fir engraver was occasionally noted along gap openings or sites with higher pine component.

Mountain pine beetle (*Dendroctonus ponderosae*) kills were associated with sugar pines previously infected to some degree by exotic white pine blister rust (*Cronartium ribicola*). Dead sugar pines greater than 15 inches were often found with galleries of MPB under the bark, while smaller diameters appeared killed directly by blister rust or other factor. Group kills were also found – a pocket of ~15 trees estimated to have died around 2008, some of which were most likely previously infected with blister rust.

Western pine beetle attacks were scattered in the landscape, attacking mature pines (average DBH>12 inches). No severe mortality had occurred in the Reynolds Creek watershed within the past five years.

Figure 3a (left). *Dwarf mistletoe plant on white fir branch.* ***Figure 3b (right).*** *Old dwarf mistletoe infection along bole of white fir.*

Within the project area, white fir was consistently observed with varying degrees of dwarf mistletoe (*Arceuthobium concolor*)(see figure 3a), *Cytospora* canker, or an unknown deformation on the bole (see figure 3b). Dwarf mistletoe was ubiquitous in stands where white fir composed >50% species composition. Hawksworth Dwarf Mistletoe (DMR) ratings[1] per trees ranged from 1 to 6; however, owning to the rarity with which these plants induce brooms in firs and the difficulty in seeing such small plants it is highly likely that the infection rates in the upper and mid-crowns of mature trees are underestimated. Large swellings of unknown origin were frequently encountered on the lower bole of otherwise healthy fir trees. These swellings were assumed to be old dwarf mistletoe infection sites, but more investigation is needed.

Conks of *Heterobasidion occidentale* were frequently found inside decaying white fir stumps. Root systems of infected stumps were frequently grafted to adjacent living white fir trees; conks were fresh and still producing spores. Surprisingly, dead snags of sugar pine (likely killed by white pine blister rust) were frequently observed than fading firs, despite firs being more prevalent. These observations suggest that *Heterobasidion*

[1] Hawkworths Dwarf Mistletoe Rating 1977. A six-class dwarf mistletoe rating system. USDA Forest Service, General Technical Report RM-48.

has maintained a "*healthy"* presence in these stands for over 50 years. However, *H. occidentale* has the potential to become a serious pest in these stands subsequent to thinning if protection measures are not taken. Prevention measures will involve application of an approved borate compound.

While a number of legacy sugar pines were showing significant branch/terminal dieback and crown decline (see figure 4), the reduction of sugar pine diversity might be the most significant observation within this project. While legacy-sized sugar pines might be able to survive the disease for many decades, the survivability of smaller-sized sugar pines is highlighted given the intense inter-tree competition against dominant firs.

Figure 4. *Terminal of mature sugar pine infected with White Pine Blister Rust.*

Discussion

Management options specifically aimed at predominantly true fir forests are not very specific as for pine. Where naturally ignited wildfire was historically frequent at low to mid-elevations, general management strategies often select against fire-intolerant species such as fir. Current management of Sierra Nevada mixed-conifer forests focus on reduction of fir and incense cedar, retaining pine and oak whenever possible (North et al 2009). Consequently, decreased fire frequencies in westside forests have elevated native insects and diseases as the primary drivers of forest disturbance and change (Smith et al. 2005).

Fir mortality is consistently correlated with drought events in California and is the most important predisposing factor (Ferrell and Hall 1975, Ferrell 1996). Mortality is often caused by a complex of bark beetles, root disease, dwarf mistletoe, and other pathogens that respond quickly to tightening physiological stress of the host. Bark beetles, particularly fir engraver, will attack in various locations where trees may be vulnerable, primarily the main terminal or at branch points along the bole where mechanical damage has occurred. Unsuccessful attacks may still disrupt water and nutrient conduction causing additional stress to hosts, as well as still inviting symbiotic fungi.

White fir mortality is often very hard to predict, but areas with prior infection of root disease, harsh site conditions, or with annual precipitation less than 20 inches per year (Schultz 1994) would be at risk for loss. Mortality patterns are often scattered and not distributed evenly among forest types or age classes when widespread die-offs do occur. Densely stocked stands, regardless of component distribution, are susceptible to bark beetle attack due to inter-tree competition for limited resources, space, and water. Prolonged drought periods exacerbate the struggle, inciting stress in pines, oaks, and other species as well. Firs with prior injury or on exposed sites are often the first to fade when annual precipitation is low or insect outbreaks are building up. Douglas fir Tussock Moth favors white firs along ridgetops, boulder fields, or south-facing slopes where harsh site conditions contribute to tree stress (Wickman et al. 1981).

Desired conditions for white fir would be that stand density, age distribution, and structural heterogeneity are such that mortality would not contribute to substantial deviations from historical vegetation patterns. Infrequent, low to mixed severity fires are characteristic for westside forests in the Sierra Nevada (Scholl and Taylor 2010) rather than catastrophic stand-replacing fires occurring within the past decade. Infection levels by pathogens or damage by insects should not be so debilitating that forest health is stagnating or

deteriorating, rather than sustained. Dead and declining trees are also a necessary part of this landscape becoming snags or coarse woody debris for habitat variability.

Management Options

- *No action.* Tree mortality caused by insects, pathogens, or other disturbances are natural complex events in the Sierra Nevada (Ferrell 1996). Background levels of mortality are often by bark beetles removing weakened, stressed individuals creating openings for new seedlings to release; root diseases in white fir are common predisposing factors that incite beetle attack eventually culminating to tree mortality. Standing or prostrate dead trees provide needed habitat, forage, and nesting sites for various wildlife species, or even substrates for other beneficial pathogens or insects that contribute to nutrient cycling.

  Past management practices and other global changes have significantly altered forest stand and structure, leading to current conditions that are highly susceptible to pest incidence and associated mortality (Fettig et al. 2007). Current conditions within the Reynolds Creek project, particularly within fir-dominated stands were found with high incidences of root disease, dwarf mistletoe, and *Cytospora* canker as mentioned previously. Root connections and grafts with other infected hosts are increased when more hosts are available on site; increasing species diversity breaks host root links reducing underground spread. Overstocked fir stands were consistently detected to have higher levels of mortality. Mortality can also be higher of large diameter (>40 inches) trees in dense stands (Smith et al. 2005). Prevention measures against further new infections of *Heterobasidion occidentale* could mitigate losses and improve vigor of residual trees especially during times of drought.

- *Thinning.* Thinning is one of the best preventive measures against bark beetles (Fettig et al. 2009). Low density stands have overall low resource competition which improve tree resistance (Fettig and McKelvey 2010). With white fir forests, host abundance is directly correlated with potential levels of mortality particularly during drought years (Egan et al. 2010). According to Oliver and Uzoh (1997), imminent mortality in ponderosa pines begins at stand density indexes of 230, maximum of 365 when losses exceed growth. As for true fir, dense stands experience higher mortality due to intensifying inter-tree opposition (Zhang et al 2007). Studies have shown that thinning from below and leaving 55-70% of the *original* basal area should maximize tree growth (Zhang et al. 2007) and reducing the proportion of white fir in the stand can mitigate losses during periods of low water yield. Care should be taken to prevent injury on residual trees. Open wounds can become entry points for pathogens and insects, indirectly increasing pest incidence.

  Thinning in pine or fir plantations should release developing trees from brush and inter-tree competition. Creating wide spacing between trees whether by mastication, hand-thinning, or prescribed fire should improve tree vigor, thus reducing beetle attraction. For pines, piling of slash or logs at tree bases should be avoided. Pine engravers (*Ips* species) will typically not attack material with bark thickness greater than 1 inch; however prudent treatments should focus on proper timing and implementation. Relocating slash away from residual stands, accelerating wood drying, or promptly treating slash will prevent beetle movement into green trees (DeGomez et al. 2008).

- *Prescribed Burn.* Fire is a useful tool that can achieve additional objectives in addition to beetle protection. However, proper timing and extreme care is recommended to avoid further injuring trees rendering them susceptible to subsequent insect attack. Slash piling to burn should also be properly timed and located as to avoid inviting beetles that can move from downed wood to standing green trees. Forest Health Protection can provide specific guidelines on proper prevention treatments.

- *Root disease Prevention*. It is strongly encouraged to utilize a preventative application of a registered borate fungicide (eg: Sporax®or Cellu-treat®) to ***all*** freshly cut conifer stumps greater than 14 inches in diameter. For best results, preventative root disease treatments should be applied within the initial four hours of tree falling. Treatments can reduce the establishment of *Heterobasidion occidentale* (S type) and *Heterobasidion irregular* (P type) onto exposed fresh stumps thus reducing the potential for tree decline or mortality. Treatments do need to be conducted wherever root disease is suspected, or if stand has the potential for infection (ex: high white fir composition). Treatments are proven effective prevention measures; even if disease signs or symptoms (P or S type) may not have been observed, prudently treating all sites should prevent subsequent disease establishment.

  It is argued that prevention treatments in fir-dominated stands severely infested with *Heterobasidion* is futile because the fungus is already established (below ground) within a communal root system. Presently, minimal damage is occurring; thereby it is expected that the next 30 -50 years *Heterobasidion* root disease will maintain the same level of presence. Living root grafted stumps associated with ideal "leave islands" of fir were observed. Recommendation would be to treat fresh cut stumps, especially where small islands firs are retained for the future. Only one or two trees in each cluster need to live for another 100 to 150 years to provide sustaining regeneration. Treating stumps along the margins of "leave islands" is an additional insurance against the uncertainty of the next century. Optimal recommendations are whole stand treatment according to the Forest Service Regional Guidelines. More information is available concerning disease biology, NEPA documentation, and proper application (see Appendix B).

Combinations of various options can be utilized to meet project objectives. If prescribed fire is used in combination with mechanical treatments, wait at least one year between treatments to allow forests to recover from initial disturbance. Chemical prevention or suppression treatments (direct controls) are not recommended here and usually reserved for high value trees or sites (ex: campgrounds) rather than general forest settings. If specific trees or areas are considered for full protection, further discussion with FHP is required.

Conclusion

Changes are happening on a global scale affecting all the world's forests, managed or not. Large scale bark beetle epidemics are occurring at unprecedented scales never recorded before in North America. Predicted warming temperatures and varying precipitation patterns will have significant effects on native insects and diseases (Bentz et al. 2010). Promotion of ecological restoration treatments should improve the sustainability and retention of forest resources in the face of climate change or other disturbance in the future. Proactive treatments are more effective, less costly, and provide benefits in the interim compared to suppression or rehabilitation that may take years to recover. Wildfires and bark beetle epidemics will occur, but mitigation and prevention efforts in forests now can significantly reduce damaging effects and losses.

Forest Health Protection supports proposed treatments that improve forest conditions at stand and landscape levels. Use of root disease prevention treatments will significantly reduce the incidence of new infection centers from establishing. Treatments that alter dense or overstocked conditions should decrease bark beetle attraction while improving overall tree vigor against other disturbance or damage agents.

If the district requires more information or has any questions regarding this report, please do not hesitate to contact us.

/s/ Beverly M. Bulaon
Forest Entomologist
209-532-3671 x323
bbulaon@fs.fed.us

/s/ Martin MacKenzie
Forest Pathologist
209-532-3671 x242
mmackenzie@fs.fed.us

cc: Ken Romberger
Johanna Nosal
Julie Lydick
Phil Cannon
Deb Romberger
Sheri Smith

References

Bentz, B., J. Regniere, C.J. Fettig, M. Hansen, J.L. Hayes, J.Hicke, R.G. Kelsey, J.F. Negron, and S.J. Seybold 2010. Climate Change and Bark Beetles of the Western United States and Canada: Direct and Indirect Effects. Bioscience 60(8): 602-613.

DeGomez, T., C. Fettig, J.D. McMillan, J.A. Anhold, and C. Hayes 2008. Managing Slash to minimize colonization of residual trees by Ips and other bark beetle species following thinning in southwestern Ponderosa pine. University of Arizona, Cooperative Extension, Publication AZ1448.

Egan, J., W.R. Jacobi, J.F. Negron, S.L. Smith, and D.R. Cluck 2010. Forest Thinning and subsequent bark beetle-caused mortality in Northeastern Californi. Forest Ecology and Management 260 (10): 1832-1842.

Felix, L. S., B. uhrenholdt, and J.R. Parmeter 1971. Association of Scolytus ventralis and Phoradendron bolleanum subsepecies pauciflorum on Abies concolor. Canadian Entomologist, Volume 103: 1697-1703.

Ferrell G. T. 1996. The influence of Insect Pest and Pathogens on Sierra Forests. *In:* Sierra Nevada Ecosystem Project: Final Report to Congress, Vol II: Assessments and scientific basis for management options. University of California Davis, Centers for Water and Wildland Resources. pg 1177-1192.

Ferrell G.T. 1974. Moisture Stress and Fir Engraver (Coleoptera: Scolytidae) attack in white fir infected by true mistletoe. Canadian Entomologist 106: 315-318.

Fettig, C., K. Klepzig, R.F. Billings, A.S. Munson, T.E. Nebeker, J.F. Negron, and J. T. Nowak 2007. The effectiveness of vegetation management practices for prevention and control of bark beetle infestations in coniferous forest of the western and southern United States, Forest Ecology and Management, 238: 24-53.

Forest Health Monitoring 2008, 2009, 2010. Aerial Survey Results: California. USDA Forest Service, Forest Health Protection, Davis, CA.

Maloney, P. and D. Rizzo 2002. Dwarf Mistletoe-Host Interactions in Mixed-Conifer Forests in the Sierra Nevada. Phytopathology, Vol. 92, No. 6.

North, M., P. Stine, K. O'Hara, W. Zielinskiand, S. Stephens 2009. An ecosystem management strategy for Sierran Mixed Conifer Forests. USDA Forest Service, Pacific Southwest Research Station, General Technical Report, PSW-GTR-220. 49pp.

Oliver, W.W. and F.C.C. Uzoh 1997. Maximum stand densities for ponderosa pine andred and white fir in Northern California. In: Forest Vegetation Management Conference. Proceedings of the Annual Forest Vegetation Management Conference Symposium Proceedings, pp. 57–65.

Scholl, A.E. and A.H. Taylor 2010. Fire regimes, forest changes, and self-organization in an old-growth mixed conifer forest, Yosemite National Park, USA. Ecological Applications 20(2):362-380.

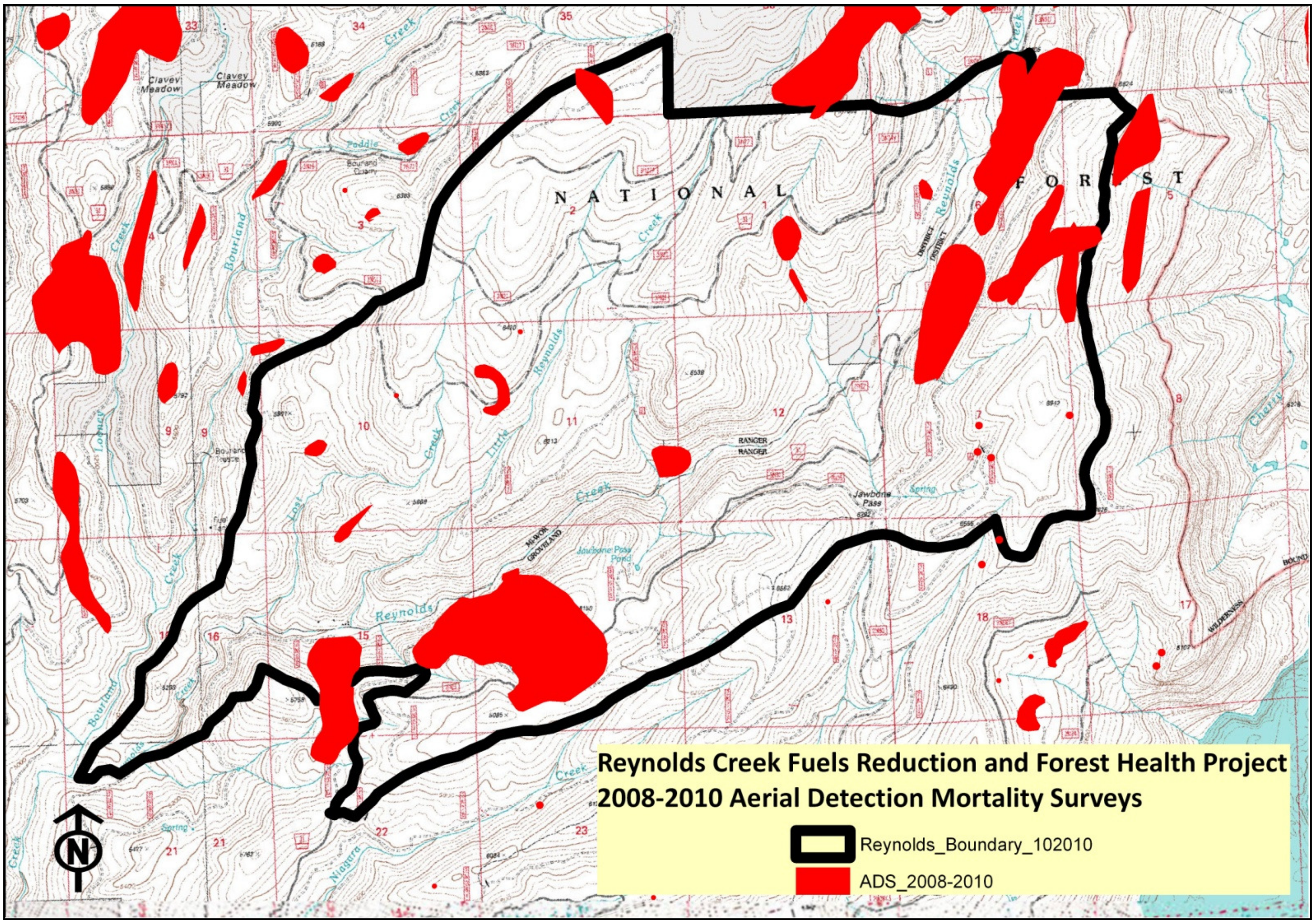
Schultz, D. 1994. Evaluation of White fir Mortality on Big Valley Ranger District. USDA Forest Service, Forest Pest Management, FPM Report NE94-2.

Smith, T.F., D.M. Rizzo, and M. North 2005. Patterns of mortality in an Old-growth mixed conifer forest of the southern sierra Nevada, California. Forest Science 51(3): 266-275.

Wickman, B.E., R.R. Mason, and G.C. Trostle 1981. Douglas fir Tussock Moth. USDA Forest Service, Forest insect and Disease Leaflet, No. 86, 11 pgs.

Zhang, J., W.W. Oliver, and M.W. Ritchie 2007. Effect of stand densities on stand dynamics in white fir forests in northeast California, USA. Forest Ecology and Management, 244: 50-59.

Appendix A. 2008-2010 Forest Health Monitoring Aerial Detection Survey.



Appendix B. *Heterobasidion* Information

The web sites listed below provide links to the most important literature on this disease and optimal protective measures.

Heterobasidion Information http://www.fs.fed.us/r5/spf/fhp/heterobasidion.shtml

- R5 Insect & Disease Manual: *Heterobasidion* (pdf 1.9 MB)
- R5 *Heterobasidion* Handbook (pdf 98 KB)
- Cellu-Treat Information, Product Label, and Material Safety Data Sheets (pdf 356 KB)
- Otrosina Heterobasidion taxonomy paper (pdf 1.5 MB)
- CA Forest Pest Conditions 2009: *Heterobasidion* (pdf 2.4 MB)

There is a white paper that should be considered prior to beginning a project-NEPA document. This white paper can be found at: http://www.fs.fed.us/r5/spf/fhp/pesticide/index.shtml It is referred to as the pesticide use advisory memorandum 06-01 (two documents on the web page: cover letter and CATS attachment ("white paper"). There is also a national risk assessment for "Borax" fungicides that discusses human as well as ecological health risks, located on-line at http://www.fs.fed.us/foresthealth/pesticide/risk.shtml

Forest Service regional policy on Sporax® is currently being updated. Revisions are still ongoing and a draft can be provided if requested (contact Dave Bakke, Regional Pesticide Specialist). As soon as the update comes back from review, it will be listed on the first web site.